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(21) International Application Number: <b>PCT/US94/10175</b> (22) International Filing Date: <b>7 September 1994 (07.09.94)</b> (30) Priority Date: <b>08/116,908</b> <b>7 September 1993 (07.09.93)</b> <b>US</b> (71) Applicant: <b>ESCALON OPHTHALMICS, INC. [US/US]; 182 Tamarack Circle, Skillman, NJ 08558 (US).</b> (72) Inventor: <b>BENEDETTO, Dominick, A.; 124 Avenue B, Bayonne, NJ 07002 (US).</b> (74) Agent: <b>SAUNDERS, Thomas, M.; Lorusso &amp; Loud, 440 Commercial Street, Boston, MA 02109 (US).</b>		(51) Designated States: <b>CA, JP, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</b>  <b>Published</b> <i>With international search report</i>
(54) Title: <b>SURFACE ACTIVE VISCOELASTIC SOLUTIONS FOR OCULAR USE</b> (57) Abstract <p>This invention encompasses a modified mucopolysaccharide solution for use as a biologically active therapeutic infusion comprising a pharmaceutical grade viscoelastic fraction selected from a group consisting of an acyl-substituted hyaluronic acid having acyl groups thereof with three to twenty carbon atoms and mixtures of said acyl-substituted hyaluronic acid with hyaluronic acid, and hydroxypropylmethylcellulose. In particular these solutions have a surface tension of between 40 and 65 dynes/cm<sup>2</sup>; particularly a viscoelastic fraction has an average molecular weight of at least 50,000. In some embodiments a physiological buffer fraction is present. This invention further encompasses a method of using the claimed composition.</p>		

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WO 95/07083

PCT/US94/10175

1           SURFACE ACTIVE VISCOELASTIC SOLUTIONS FOR OCULAR USE

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3           This application is a continuation-in-part of copending  
4 U.S. Pat. App. 08/061,773 filed May 13, 1993, which is a  
5 continuation of U.S. Pat. App. 07/440,078 filed November 22,  
6 1989, now abandoned.

7  
8                           Field of the Invention.

9           The present invention relates to ophthalmic solutions for  
10 use during ocular and intraocular surgery, and more particularly  
11 to the use of surface active viscoelastic solutions during the  
12 extraction of a cataractous human lens and the implantation of a  
13 prosthetic ocular and intraocular lens. During surgery, the use  
14 of ophthalmic infusions with controlled physical properties,  
15 especially surface activity and viscoelastic properties, is  
16 advantageous for (1) replacing the fluid aqueous humor or ocular  
17 and intraocular air, (2) protecting the internal structures of  
18 the eye from accidental instrument or ocular and intraocular  
19 prosthetic device contact, (3) preventing irrigation damage by  
20 solutions used in routine cataract surgery, and (4) retarding  
21 aspiration from the eye of the viscoelastic solution during the  
22 surgical procedure. In addition, the invention relates to a  
23 method of adhering a contact lens to the surface of the eye,  
24 such as in association with procedures permitting a medical  
25 professional to view ocular and intraocular structures through  
26 the contact lens and through the viscoelastic solution. In  
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WO 95/07085

PCT/US94/10175

1 another application, the viscoelastic solution of this invention  
2 is used by injecting the solution into or under tissues within  
3 the eye, such as to dissect tissue off of the retina.

#### 4 Background of the Invention

5 In the past, biocompatible polymers used in ocular and  
6 intraocular surgery have been the naturally occurring  
7 mucopolysaccharides hyaluronic acid and chondroitin sulfate;  
8 mixtures of hyaluronic acid and chondroitin sulfate; and,  
9 cellulose derivatives, such as hydroxypropylmethylcellulose  
10 (HPMC). Table 1  
11 presents data reported in Viscoelastic Materials, Ed. E.S.  
12 Rosen, Proceedings of the Second International Symposium of the  
13 Northern Eye Institute, Manchester [U.K.], 17-19 July, 1986  
14 (Pergamon Press, New York) as to the molecular weight of  
15 commercially available ocular products. Depending on the source  
16 from which these mucopolysaccharides are drawn, the molecular  
17 weights are estimated in the 50,000 range with the hyaluronic  
18 acid extending upwards to the  $8 \times 10^6$  range. Hyaluronic acid  
19 was first isolated and characterized by Meyer, Palmer and  
20 reported in the J. Biol. Chem., Vol. 107, p. 629 (1934) and Vol.  
21 114, p.689 (1936) and by Balazs in the Fed. Proc. Vol. 17, p.  
22 1086 (1958); and chondroitin sulfate by Bray et al. in Biochem.  
23 J. Vol. 38, p. 144 (1944); and Patat, Elias, Z. Physiol. Chem.  
24 vol. 316, p. 1 (1959).

25  
26 Literature in the art describes the basic isolation and  
27 characterization of the viscoelastic solutions. It is a  
28 surprising feature of this invention which describes the control